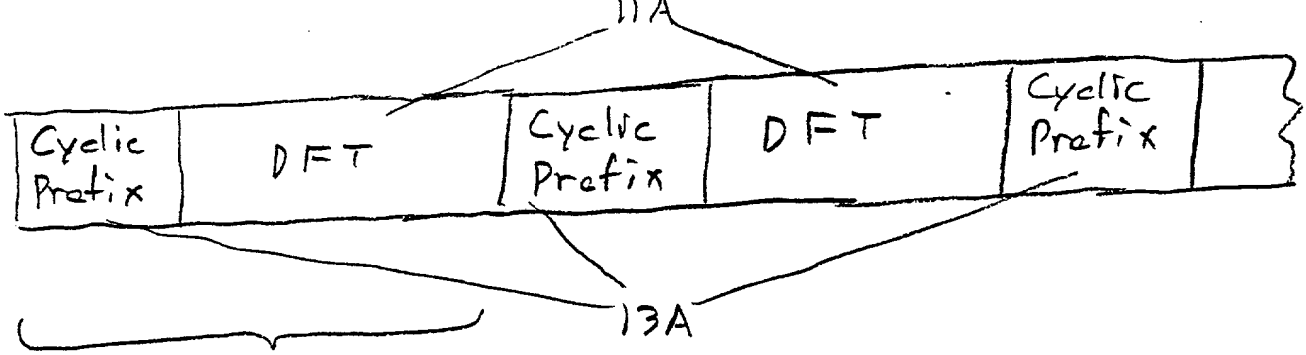


FIG. 1A

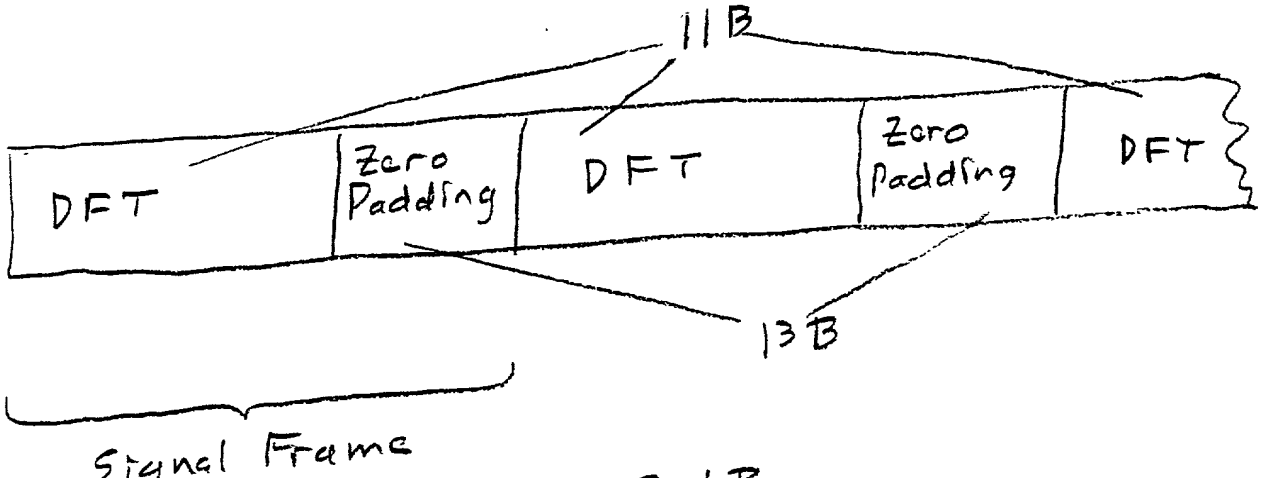


FIG. 1B

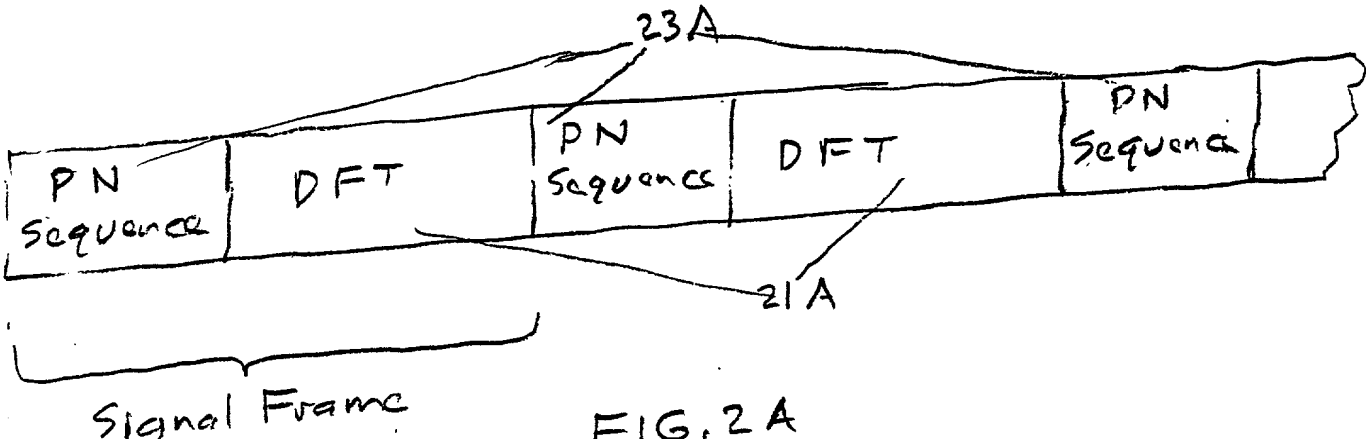


FIG. 2A

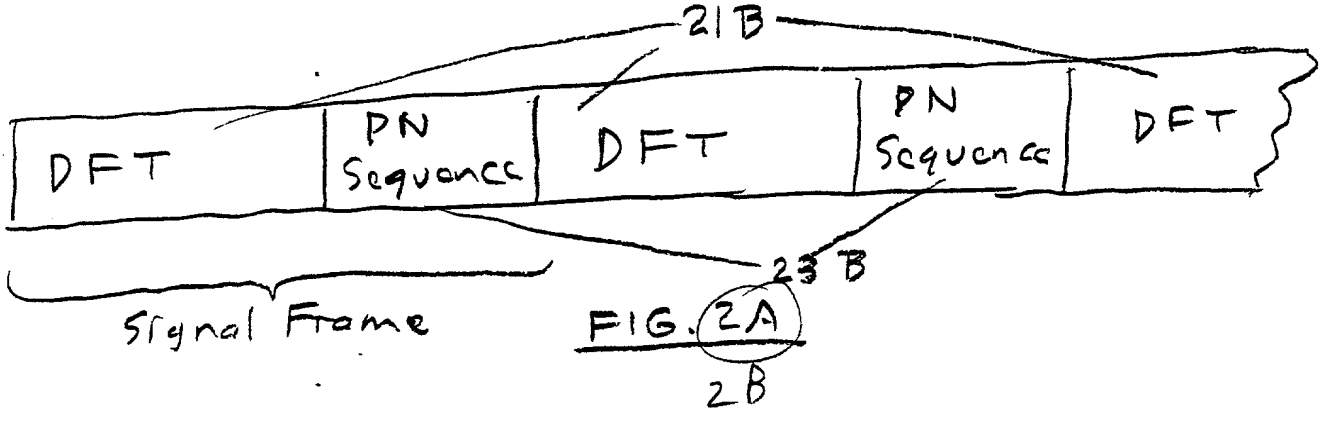


FIG. 2A

2B

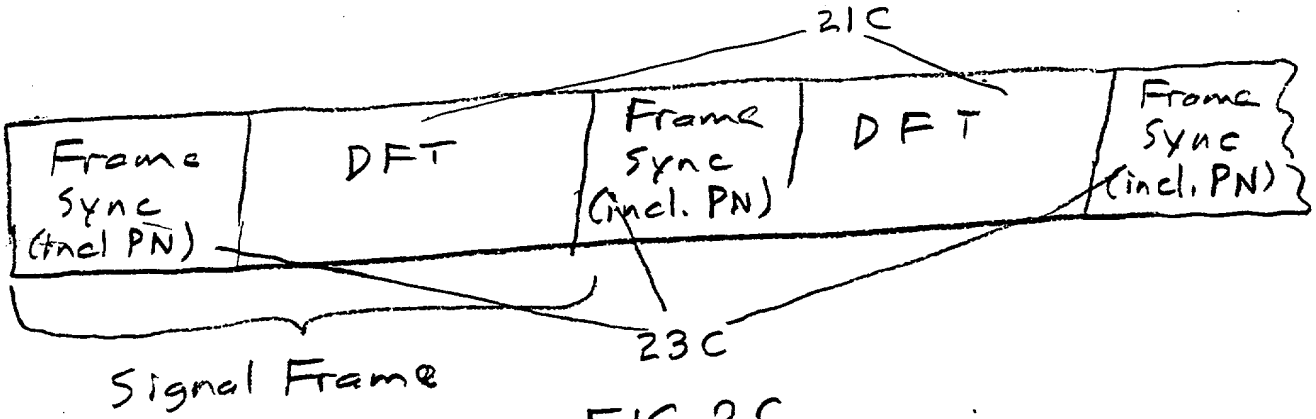
21C
Frame Sync (incl PN)
DFT
Frame Sync (incl. PN)
DFT
Frame Sync (incl. PN)
23C
Signal Frame

FIG. 2C

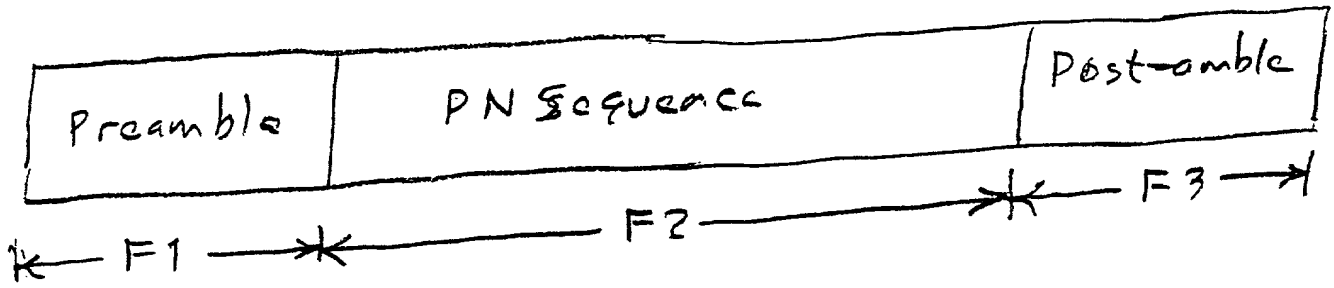
Preamble
PN Sequence
Post-amble
F1
F2
F3

FIG. 3

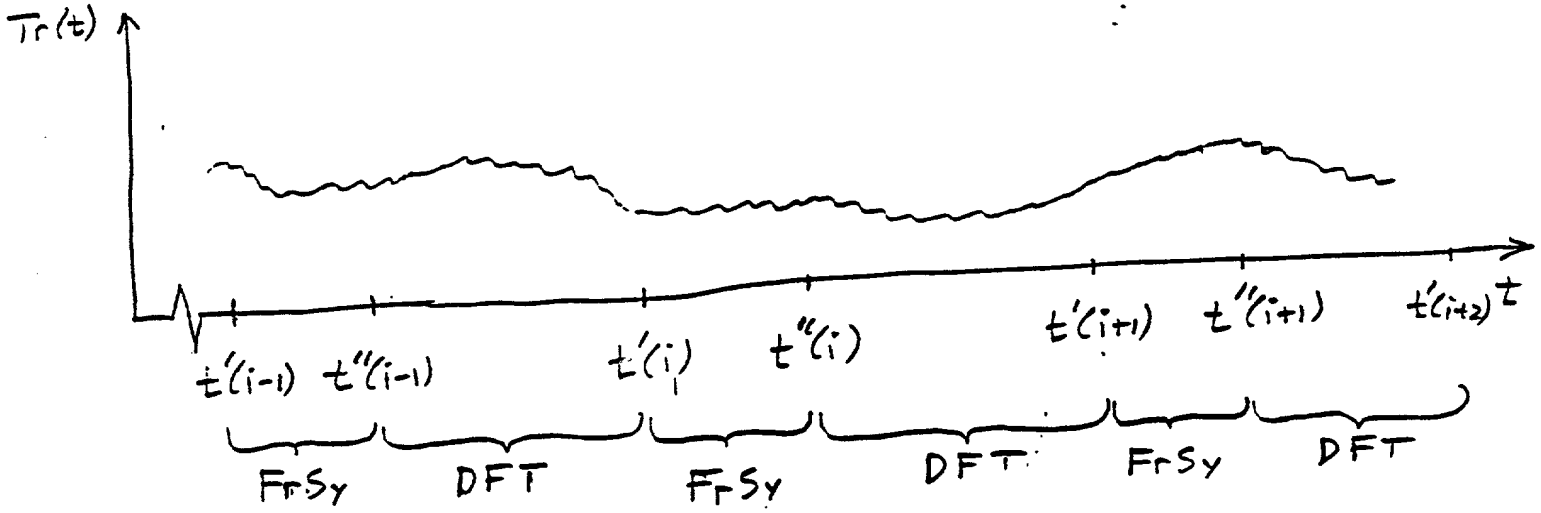


FIG. 4

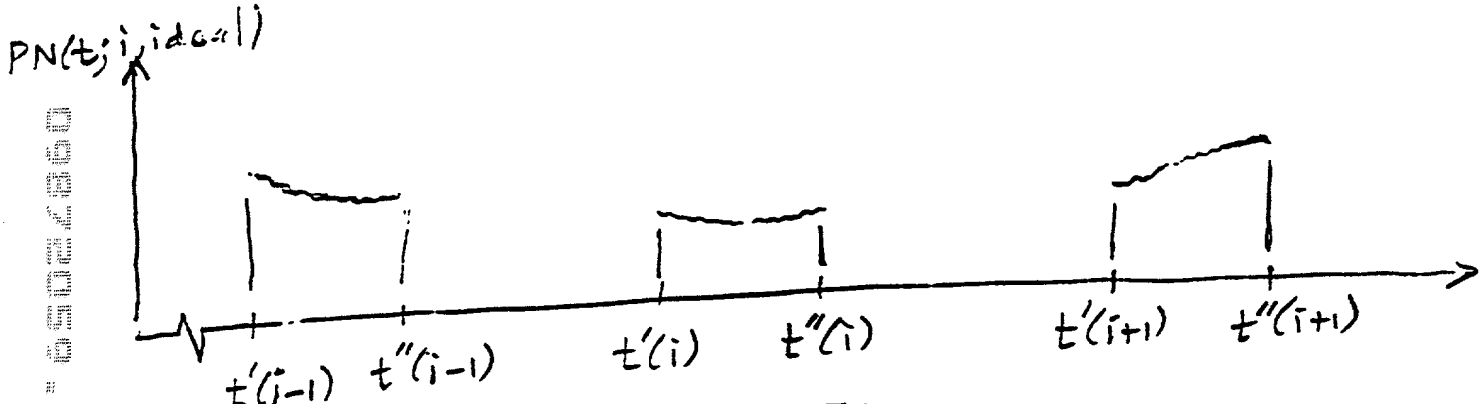


FIG. 5A

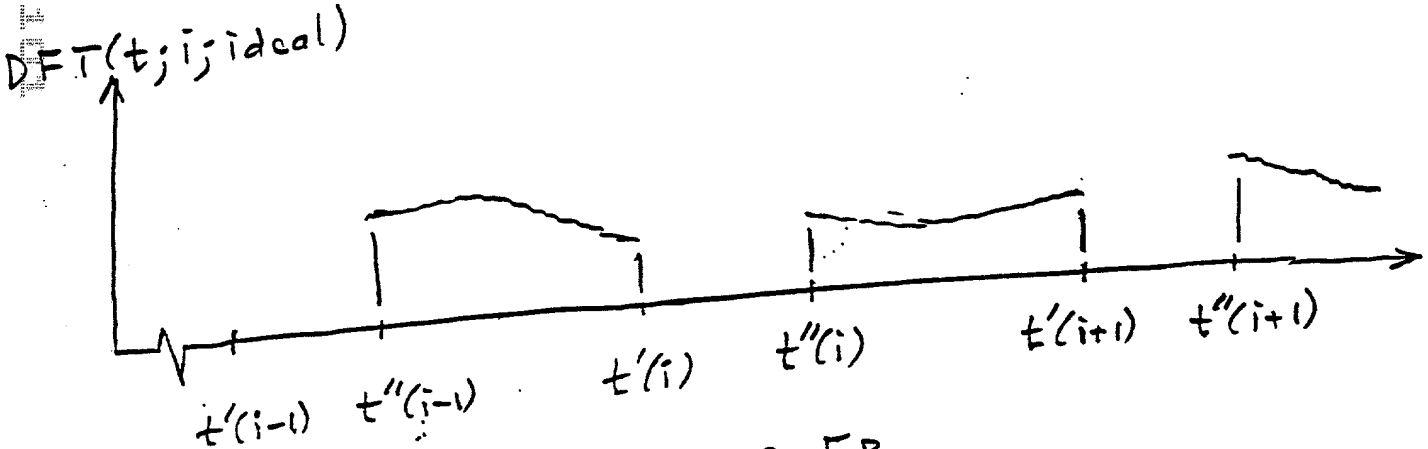


FIG. 5B

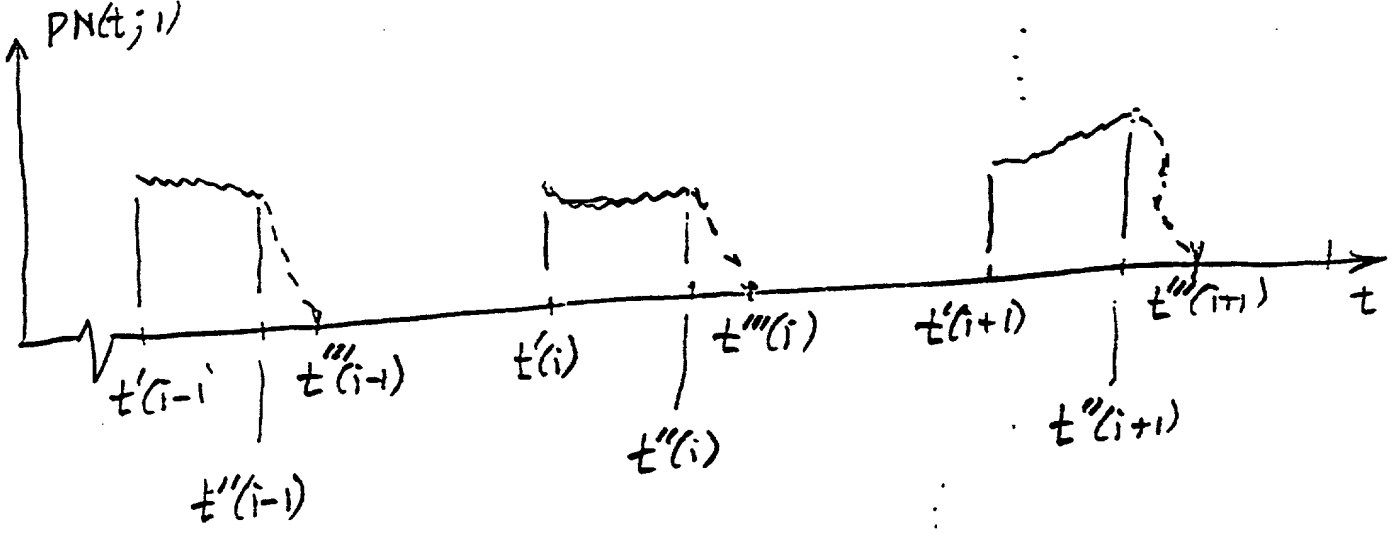
PN(t;i)
t'(i-1)
t''(i-1)
t'''(i-1)
t'(i)
t''(i)
t'''(i)
t'(i+1)
t''(i+1)
t'''(i+1)
t

FIG. 6A

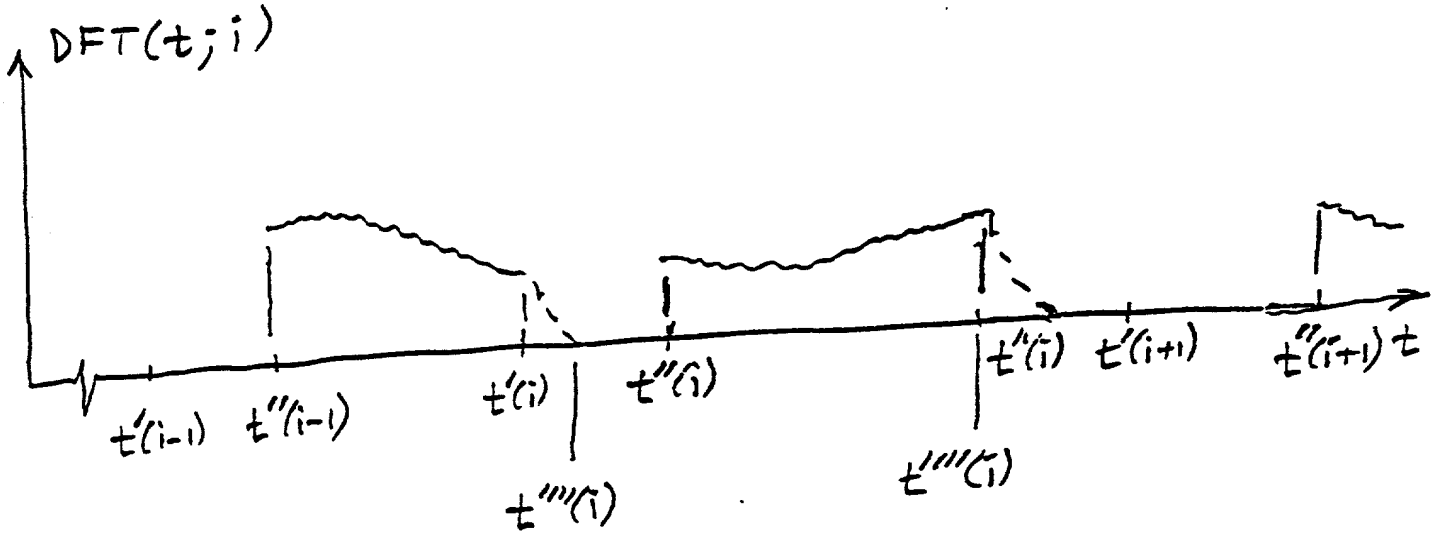
DFT(t;i)
t'(i-1)
t''(i-1)
t'''(i)
t'(i)
t''(i)
t''''(i)
t''(i)
t'(i+1)
t''(i+1)
t

FIG. 6B

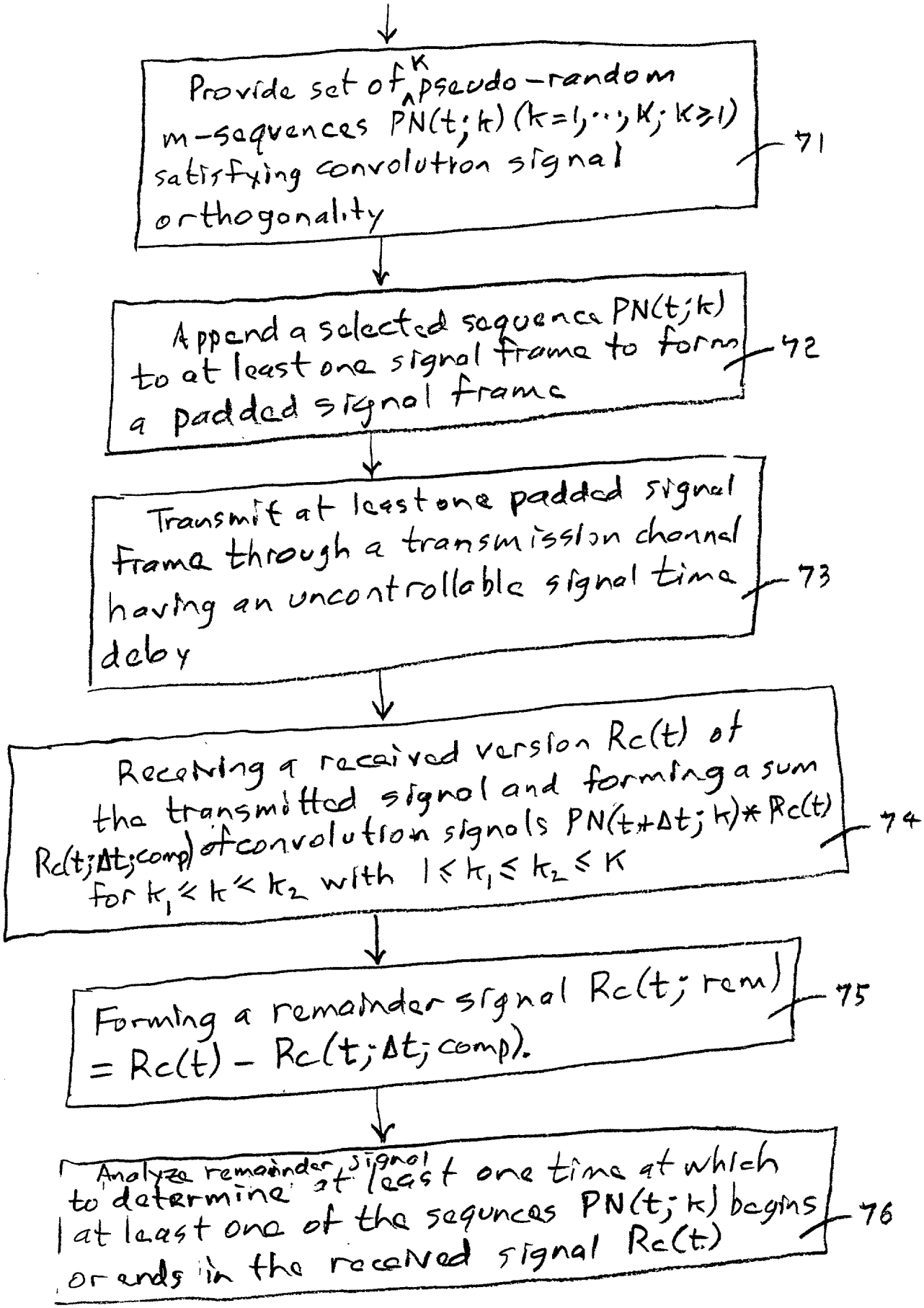
Provide set of K pseudo-random m-sequences PN(t;k) (k=1,...,K; K≥1) satisfying convolution signal orthogonality
71
Append a selected sequence PN(t;k) to at least one signal frame to form a padded signal frame
72
Transmit at least one padded signal frame through a transmission channel having an uncontrollable signal time delay
73
Receiving a received version Rc(t) of the transmitted signal and forming a sum Rc(t;Δt;comp) of convolution signals PN(t+Δt;k)*Rc(t) for k1≤k≤k2 with 1≤k1≤k2≤K
74
Forming a remainder signal Rc(t;rem) = Rc(t) - Rc(t;Δt;comp).
75
Analyze remainder signal to determine at least one time at which at least one of the sequences PN(t;k) begins or ends in the received signal Rc(t)
76

FIG. 7

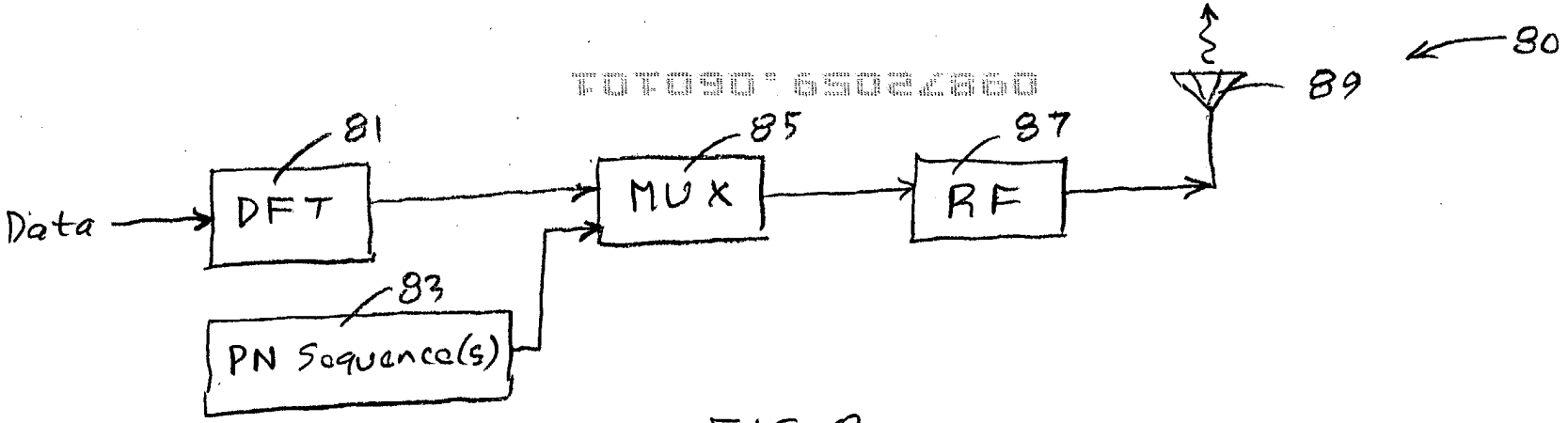
80
89
81
85
87
Data
DFT
MUX
RF
83
PN Sequence(s)

FIG. 8

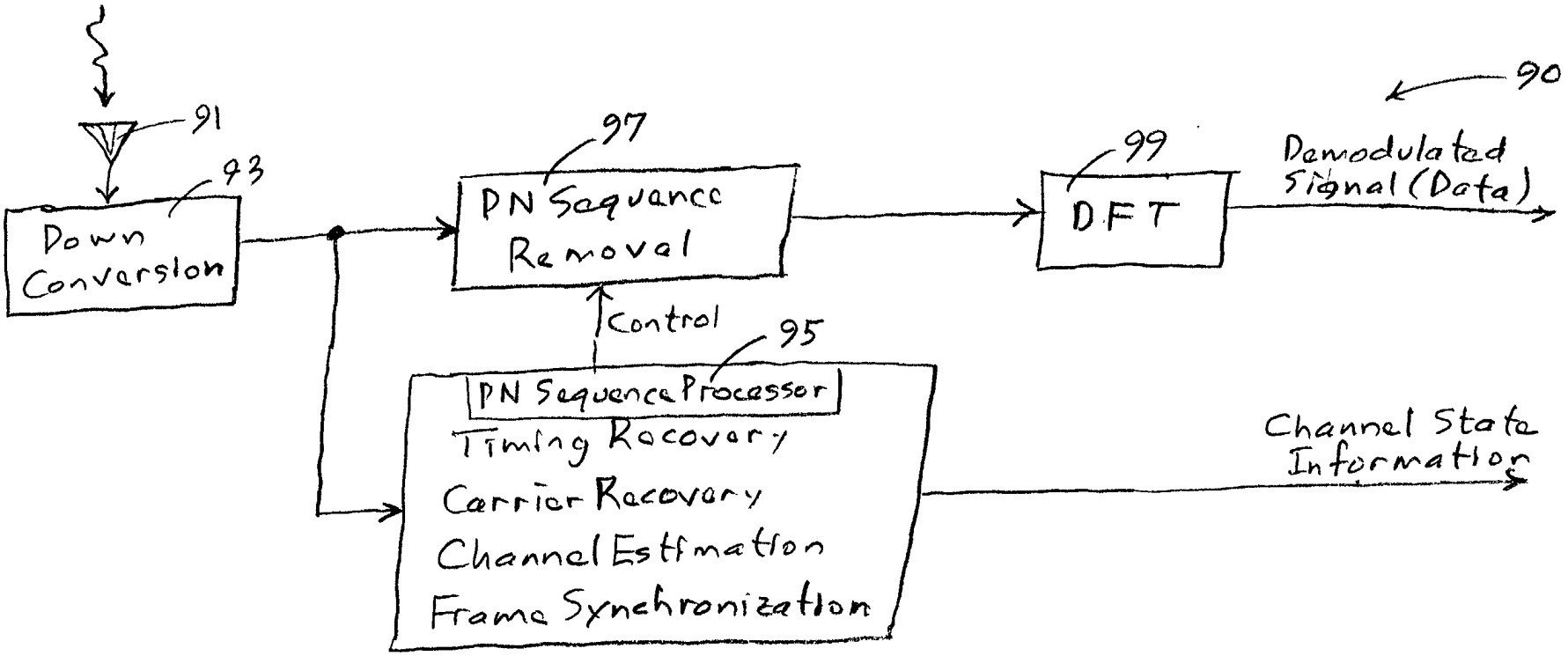
90
91
93
97
99
Demodulated Signal (Data)
Down Conversion
PN Sequence Removal
DFT
Control
95
PN Sequence Processor
Timing Recovery
Carrier Recovery
Channel Estimation
Frame Synchronization
Channel State Information

FIG. 9